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WITH THE AUTHOR'S COMPLIMENTS.

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RELATIVE FREQUENCY OF COLOR-BLINDNESS IN MALES AND FEMALES.

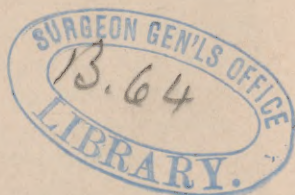
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RELATIVE FREQUENCY OF COLOR-BLINDNESS IN MALES AND FEMALES.

BY B. JOY JEFFRIES, A. M., M. D.

IN an article written last fall on the dangers of color-blindness, and recently published in the Massachusetts State Board of Health Report, I stated, "It has been frequently said that color-blindness was less common among females than males. This is *probably* incorrect, and due to the fact that such a defect is of more importance with the female sex, and therefore more carefully concealed. They have not been tested as males have; and most likely future statistics, based on true methods of testing, will reverse the now quite general impression as to their having better color perception, and hence to be preferred, where admissible, as railroad employés."

My doubt was also based upon the fact that we had no large number of reliable statistics to prove the contrary. But more especially because methods of testing for color-blindness in females had been employed, calling upon the observed to name colors shown, which females from habit could unquestionably do with greater facility than men, and hence fewer appear deficient in color perception. Professor Wilson, in his *Researches on Color-Blindness*, says, page 75, "I have no results to offer respecting the prevalence of color-blindness among females. I have already stated my conviction that it is rarer among them than among males, but only an extended inquiry can show the amount of difference in this respect between the sexes." In a note in his appendix, page 164, he adds, "Since the text was written I have been informed of a few more cases of color-blindness among educated women in England. The general tendency, however, of my later inquiries, as of my earlier ones, is to show that color-blindness is very much rarer among women than men."

Dr. A. Favre, in an article in the *Gazette hebdomadaire*, October 12, 1877, says, "We have tested very few adult females, from the difficulty of such examinations, but more especially because the majority of women readily acquire an exact notion of colors, and they do not belong to the professions where color-blindness is dangerous; hence they do not interest us more in an industrial than a medical point of view. Among 236 girls of four schools (three in Lyons, one in Paris) we

found 8 children only who made serious mistakes, namely, 3.39 per cent. In the 'salles d'asiles' and the infant schools the errors were as frequent among the little girls as boys."

It must be remembered that Dr. Favre reported an enormous number of children of both sexes as color-blind, but he tested them by asking the names of the colors of objects held up before them. He found, as may be readily imagined, many of the youngest children of both sexes unable to answer correctly, whilst among the older children the girls had naturally learned the names of colors better than the boys. This I think is all that his test proves, as I have shown in the March 28th number of *The Boston Medical and Surgical Journal*, 1878.

In 1860 Dr. Henri Dor, of Bern, tested in Berlin 611 women, using a method similar to that of Professor Holmgren's, namely, the sorting of colored worsteds, with the result of finding only five or 0.82 per cent., or one in 122 color-blind. This method does not call upon the examined to name a color, and the eye alone, not memory, guides the hand. Its value is shown by the results it gave. Perhaps these investigations of Dor's should have prevented my doubting the less frequent occurrence of color-blindness in women than men. They seemed, however, to stand somewhat alone, and not sufficiently extended. Perhaps the same criticism will be passed upon my own, shortly to be reported. Professor Holmgren, in his recent work on color-blindness, touches on this point, and as his experience renders what he says of special value I quote his remarks: ¹ "Our results thus far are principally derived from the examination of men. Therefore we do not venture to deny the commonly admitted statement that color-blindness is more frequent with men than women, since we lack the necessary data. We should mention here Professor Dor's test of the quite respectable number of 611 women in Berlin, amongst whom he found but five color-blind, or less than one per cent. We would by no means deny the possibility of a less frequent occurrence in women; on the contrary, we incline to believe that it is probable. In drawing conclusions from the statistics of the examination of women hitherto made, we must first of all ascertain if the method of testing was such that the previous occupation of the examined had not affected the results obtained. For if the method was based on the principle of asking the names of the colors of objects exhibited, and the chromatic sense of the person examined judged by the reply, then it is very evident that the proportion of color-blind will appear less with women than men. We are by no means certain that this is not the explanation of the results so far ascertained. However this may be, and even admitting that color-blindness is less common in women than men, we are by no means justified in attributing this to their greater familiarity or exercise with colors. If exercise can have

¹ De la Cécité des Couleurs, etc., page 57. Stockholm. 1877. F. Holmgren.

any such influence, it cannot, as we have seen, cure the individual, but rather affect the offspring, as employment insensibly affects future generations. The laws of heredity are too little known to allow us to indicate or even conjecture how this takes place, but we do know with certainty that good qualities as well as defects are transmitted, and amongst the latter we may include color-blindness. We believe, moreover, that the exercise of a sense may favorably affect heredity, although it is difficult for us to prove this."

Probably at the present moment observers in Europe are testing this question of the relative color-blindness of the two sexes. Their results, if Professor Holmgren's method is employed, will be of great value. The only reports of this character yet come to my hand are those of Dr. E. Hansen, of Copenhagen, who found none color-blind among 50 female railroad employés, and of Dr. A. Daae, of Kragerö, Norway, who also used Holmgren's method with the worsteds in examining 413 school-children of both sexes, from nine to fifteen years of age.¹ Among 205 boys he found 10 color-blind and 11 with imperfect color perception. Amongst 208 girls he found none color-blind, and only five with imperfect color perception (*herabgesetzter Farbensinn*). He says: "The better color perception of the girls than the boys was very marked. Is this because the girls have personally more exercise with colors than the boys? If this is the case, then we must assume that even very considerable degrees of color-blindness may be relieved by many years' exercise. This is, however, not probable. It is more probable that the better color perception which the female sex has acquired and developed by many generations of handling colored objects is essentially sexual, or only inherited by the female descendants."

Since February, 1878, when I published an article on the incurability of congenital color-blindness, my experience with intelligent and educated persons thus afflicted has fully substantiated what I then said, namely, that it has not been and cannot be cured by exercise with colors. The color-blind reported to me their futile attempts to do this, as others, for instance, reported to Professor Wilson years ago, and to Professor Holmgren more recently. Greater familiarity with and more constant use of colors on the part of females seems at first sight to explain their somewhat extraordinary exemption from color-blindness as compared with males. This does not, however, affect the individual. Whether the individual is influenced through generations of female ancestors exercised with colors I must for the present leave with Mr. Darwin to discuss.²

¹ Vide Magazin for Lægeridenskaben, Bd. 7, Heft vii., 1877; or Centralblatt für Aug., April, 1878.

² Professor Delbœuf, of Liège, reports in the March 23d number of the *Revue scientifique* that by looking through a solution of fuchsine he was enabled to correct in a great measure his red-blindness. M. Spring, who worked with him later, found that he could render himself color-blind by looking through a solution of chloride of nickel.

In any such discussion there are some points of heredity which must not be overlooked. The very first case of color-blindness ever published was that of a shoemaker named Harris, in a letter of Mr. Joseph Huddart to the Rev. Joseph Priestley, January 15, 1777, to be found in the Philosophical Transactions of the Royal Society of London, Part I., 1777: "He had two brothers in the same circumstances as to sight; and two other brothers and sisters who, as well as their parents, had nothing of this defect." The transmission of the defect in the male line alone is very frequent. But there are cases of the reverse on record. Dr. Pliny Earle reported out of 61 relatives — 32 males and 29 females — 20 cases of color-blindness, two of these being females. Again, Cuvier, in the first volume of the *Annales d'Oculistique*, 1838, reports the case of a lady who was color-blind. Her mother and two sisters were the same. Her brother was free from the defect. The lady had six children, — one son not color-blind, and five daughters affected like herself. The oldest daughter had four children; two of them girls, color-blind. The second daughter had a boy and a girl, the latter color-blind. The fourth daughter unmarried. The fifth left a boy myopic, but not color-blind. We thus have the remarkable instance of color-blindness appearing only in the females of a family for four generations. Heredity has here apparently acted without reference to or directly against the accumulated effects of generations of exercise with colors. My own experience agrees with Professor Wilson's in England, namely, that hardly a person affected with color-blindness will be found who cannot remember or mention one or more relatives with similar defect of vision. It has seemed to me to act as any other family peculiarity or mark; for instance, skipping one to appear again in the succeeding generation, etc. It is certainly a very curious fact that if generations of exercise with colors is gradually eliminating color-blindness from females, this should not have checked its transmission through females exclusively for four generations.

My own results as to the relative frequency of color-blindness in males and females are as follows. In the Institute of Technology in Boston, the various departments of Harvard University, Amherst College, and Brown University, I have tested 1021 students and instructors, finding 46 color-blind, or about one in 22. This corresponds with the average experience of European observers. I used Holmgren's method, with colored worsteds. It did not seem necessary to test *all* students of these institutions, even if it were possible, since my ratio is wholly borne out by examiners on the other side of the water. As to females, I considered it necessary to test each and all of any one institution. I therefore commenced at Wellesley College, and was surprised to find but one color-blind girl among 302. Her mother, she told me, was also color-blind. Five or more of the students voluntarily mentioned having color-

blind blood relatives. This result appeared so extraordinary that I should have been inclined to doubt the test, or my own ability to apply it properly, had I not already familiarized myself with it in several hundred of previous examinations of men. I therefore felt it necessary to push on in this direction with institutions where I could be assured of being able to test each and all, and am now at work in the public schools of Boston by permission of the school board. I would so far report as follows: In the Girls' Normal School, Boston, 84, being all, and none color-blind. Their ages, eighteen to twenty-two. In the Girls' High School 549, being all, none color-blind. Ages fourteen to twenty. Seventeen of the girls of this school told me they had blood relatives color-blind. Exeter Street School, all the girls, numbering 90, none color-blind. Ages eight to sixteen. Thus I found but one color-blind among 1025 females, whilst among 1021 men I found one in 22 deficient in the chromatic sense. The relative proportion of the three forms of color-blindness — red, green, and violet — I will not enter into here, but merely remark that I found, as other observers have, the first much the more frequent, whilst of the last only three cases occurred, and these by no means so marked as the other forms. As to the value of these results, I admit that they of course depend on the exactitude of my observations. I therefore would say that from familiarity with the test I feel perfectly sure that I detected color-blindness where it existed. I always pushed the test much further than would seem necessary, often thereby causing remark and question from the bystanders. Although seemingly tedious and monotonous from the tax upon the eye and ear and voice of the examiner, I found my tests of great psychological interest, frequently shared in by educated observers.

Since this paper was first read I have received the reports of Drs. Hermann Cohn and Hugo Magnus in Breslau, who the past winter have been like myself engaged in the examination of school-children for color-blindness. They employed the same method as myself, namely, Professor Holmgren's, and their results agree with mine above given. Among 2761 boys they found 76, or 2.7 per cent., color-blind. Among 2318 girls they found only one color-blind, or 0.04. This defect seems, therefore, a very great rarity among females. Color-blindness occurred twice as often among Jewish children as among Christians. The single case among girls which Dr. Cohn found was one of red-green and blue-yellow blindness, quite atypical.

